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(54) A PROCESS FOR PRODUCING A RETICULATED SHEET AND A RETICULATED SHEET PRODUCED IN ACCORDANCE WITH THE PROCESS

(71) We, BREVETEAM S.A. of CH 1700 Fribourg, Switzerland, a Swiss body corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

Network structures made of fibres or strands of plastics material are used to an increasing extent for packinging and transporting purposes. Generally such nets are made by extruding strands of plastics material, the strands being laid one upon the other and welded together at the intersections. In this manner it is only possible to produce a net which is uniform over its whole surface, i.e. it is not possible to vary the net structure within the net. Moreover, such a net has thickened portions at the intersections which in the case of nets made of thick plastics strands produces an uneven appearance when the net is used an underlay or intermediate layer.

An object of the present invention is to provide a reticulated film or sheet net structure which may contain apertures of a variety of shapes. For convenience, the word "sheet" will be used to include both sheet and film material. Moreover, the production process is simple and cheap, and enable nets and net tubes of practically any width or length to be made. To provide such structure we use shrinkable synthetic high polymer organic (non-fibrous) material sheets, more particularly thermoplastics material sheets. This includes sheets of material which shrink when subject to the action of swelling agents. When using heat-shrinkable thermoplastics material sheets, the process of the invention uses a sheet of the material pierced with rows of substantially parallel and mutually offset slits, the sheet having a shrinking direction substantially at right angles to the slits; the sheet is heated to a temperature producing some degree of softening, at which the web material between the slits shrinks to form thickened webs, thus opening the slits by contraction between the centres of juxtaposed slits to form a reticulated web or net.

When using a thermoplastic sheet which shrinks under the influence of solvents, the process in accordance with the invention employs a sheet provided with parallel rows or slits offset relative to one another, the sheet having a direction of shrinkage substantially at right angles to the slits, the sheet being subjected to a swelling action to cause subsequent shrinkage so that the material between the slits shrinks to form thickened webs, thus opening the slits by contraction between the centres of juxtaposed slits.

When using thermoplastics material sheet a heat-shrinkable material is obtained, if such thermoplastics sheets are initially stretched during manufacture. This stretching, when producing plastics sheet from an extruder, may be effected by drawing the still hot plastics material at a higher rate than the extrusion rate. The plastics sheet as produced has a direction of shrinkage which corresponds to the direction of stretching. The more the draw-off speed is increased relative to the extrusion speed, the greater the tendency to subsequent shrinking. Thus the basic

principle of making shrinkable material sheets is that these derive their shrinking tendencies from an initial stretching of the material. Such materials usually contist of large molecules, in this case of thermoplastic raw materials of long chain (high-polymer) polyethylene, polyvinyl chloride, polyamide, short chain polyethylene, polypropylene and co-polymers. In the case of some crystalline materials, such as co-opolymers, stretching is effected if necessary at a temperature above the crystallite melting point.

Sheet which is pre-treated by irradiation or by solvent action, such as for example as highly polymerised polyethylene, is usable, since in the pre-treating process the sheet has shrinking tendencies imparted thereto by eliminating previously present thermoplastic properties. In rubber or like materials the tendency to shrink may be produced by stretching the material under heat after vulcanisation and freezing it in this state.

The use of plain sheet allows any printing required to be applied thereto before the reticulation process, and such printing may be carried out either before slitting or after slitting. In either case a substantially smooth material face is provided for the printing. The subsequent shrinking process then creates a net of uniform thickness which has no thickened joints. This shrinking provides webs in which the thickness of the strands has increased relative to the thickness of the original material sheet, the cut edges and ends becoming radiused so that the resultant net has a high resistance to tearing. The strand thickening resulting during shrinking is important because this provides webs of considerably greater thickness than the maximum thickness of blown sheets, which owing to their relatively low price are of particular interest to the process of this invention. The release of the shrinking forces produces a material which has no tendency to shrink further later. The use of a material sheet provided with slits as a basis has the advantage that sheets of any available width may be used, and hence nets of any required size may be produced. No difficulties are encountered in providing the material sheet with a variety of slits. Thus certain areas of the sheet may not be slit or the slit pattern may vary between one area and the next, so as to produce a varying pattern throughout the net. Other patterning may include the step of masking certain regions from the shrinking process.

The production of offset slits in parallel rows in plastics material sheets is known. It may be performed continuously with rotating cutters. Such slitting is followed by the process of shrinking; if heat-shrinkable thermoplastic material sheets are used as a basis, these are conducted through a heating region, in which shrinking and hence the formation of the reticulated web structure occurs. It is, of course, also possible to enclose an article to be packaged with such a slit sheet, the net being formed by shrinkage to fit closely around the article.

The opening of the slits by shrinking into angular, more especially hexagonal holes, is an effect which may be explained as follows: Between the centres of slits located on the same level and in juxtaposition, the shrinkable material is of relatively great length, and during shrinking contracts considerably between the slits. This contraction occurs at all parts of such a slit material so that at the end of a slit a state of tension occurs acting in the said shrinkage direction, this tending to spread the slit apart. From each end of a slit two webs are formed, so that a honeycomb structure remains which provides the required reticulated structure. The first thing expected to occur when heating such a slit sheet is a uniform ontraction of the sheet without opening the slits; this however does not happen since the slits are normal to the direction of shrinkage of the sheet.

A reticulated structure in accordance with the present invention may be used wherever a net-like structure is required. This applies, for example, to packaging nets, fishing nets, protective nets and so on, more particularly where some elasticity is required. Such protective nets may include fly netting. The netting may be used for disposable bandages. Strong nets with considerable stretch made of polyamide, polyester or the like may be used for braking or slowing down moving masses such as avalanches or aircraft in which case the re-stretching up to the maximum strength of the material absorbs energy. The invention may also be applied where a net structure is required for aesthetic reasons, such as for curtains. The net-like structure may also be used as basis for garments.

A further field of application is that in which the net structure has to fulfil an auxiliary function, as for example when used as backing material. Another application is when the net is used to form a permeable layer such as a carrier for a filter material.

Straight slits and pattern forming slits may be used. Straight slits involve a particularly economical production method, since rotary cutters may be used. Various optical effects may be obtained by means of pattern-forming slits. The outer appearance of the net may also be influenced by combining various types of slits, or leaving a region of unslit material between rows of slits. If the plastics material sheet to be shrunk also has a shrinking direction parallel to the slits, then smaller openings are obtained as compared with a plastics material sheet having only a direction of shrinking substantially at right angles to the slit direction if the lengthwise

shrinking is not prevented by clamping. The size of the openings can thus be influenced by suitably choosing the shrinkage properties of the plastics sheet. A further possibility of controlling the size of openings formed during shrinking consists in elongating the sheet during heating, at right angles to or longitudinally of the slits. This elongation however is not the same as the known method of stretching to increase the strength of a sheet, since this occurs below the plasticizing range of the thermoplastic material. It is also possible to control the size of the openings by the intensity of shrinkage, i.e. the greater the tendency of shrinking in the direction transversely to the slits, the larger the holes. A condition for this, of course, is that the shrinkage is not hampered by pressing the sheet between two rough surfaces.

The process of the invention is applicable not only to flat sheets since it is possible to produce a net-like tube therewith. For this purpose a tube is used as the shrinkable base which is slit whilst flattened and subsequently shrunk. A parting agent may be used inside the tube to prevent the inside of the tube from adhering. Mechanical separating means such as a mandrel provided with a recess of sufficient length may be used, over which mandrel the slit tube is drawn, and heated in the region of the recess.

When the net to be produced must be particularly strong, then a plurality of layers of sheet web are slit and shrunk together, the individual layers combining to form a composite structure. If the layers have also been slit together, then a strong and uniform net is formed. With separate and different slitting a corresponding net combination is formed. Thus, the shrinking process is doubly exploited; on the one hand by opening the slits, and on the other hand by causing the individual layers to adhere by heating, so that a compact unitary structure is formed. In this manner it is possible to produce nets of increased thickness based on cheap, blown sheets. If two sheets of different colours are used, then nets are produced which have a different colour on each side.

Both a homogeneous thermoplastic sheet or heterogeneous thermoplastic foam sheet may be used as a shrinking medium. A slit mat-like plastics foam produces an elastic mat-like structure which is well suited to act as a carrier or underlay material. High molecular weight polyethylene, polypropylene, polyamide, polyvinyl chloride, polyester and similar substances may be used to make such foams.

The recticulated structure of the invention may be cemented to another sheet. This can be carried out in various ways. Thus, it is possible to affix a further unslit material sheet on the network after slitting and shrinking; adhesion can be effected by shrinking at a temperature sufficient to soften the network, apply the unslit sheet thereto and cool the combination. A structure may be formed in which a network is reinforced by an imperforate foil. The resistance to progressive tearing of the foil is considerably increased by the net.

The net-like structure may also be used as a substitute for fabrics and woven goods, whereby the thickness and net dimensions can be varied by selecting the number of layers, slit length, slit separation and slit pattern. One possible use is a potato sack, the jute fabric of which can with advantage be replaced by a net of the present invention. If the net is used as carrier or bottom layer for a needle felt, then no only is the netting rot-proof, but due to the annealing process occurring during shrinking, it remains of absolutely stable dimensions and thereby prevents swelling of the finished article.

A further material web with a lesser or zero tendency to shrinking such as paper, may be applied to a base sheet before slitting, whereupon the combination is slitted and shrunk. Depending upon whether the further material web is completely bonded with the shrinking web, or only at different points by spot welding, a variegated structure is formed after shrinking. With complete bonding between the shrinking sheet and the non-shrinking sheet the net strands have a certain curvature imparted thereto, which may be attributed to the fact that one web contracts more than the other. The shrinking web is then located on the inner surface of the curved product. If the two sheets are bonded at a few points only, these will lift off one another during shrinking, at the unbonded points, giving the appearance of a loose structure.

The extra layer may be a hot-melt adhesive film which is applied in a hot state to the shrinkable sheet at a temperature below shrinking temperature, and slit and shrunk with the shrinkable sheet, whereby it concentrates on the strands and net nodules thereof. This material may be rendered adhesive by heating, and then cemented against a surface.

Again, two sheets are affixed to a shrinkable sheet one on each side, or a shrinkable sheet may be adhered to both sides of a further sheet. The later process provides textile-like structures which due to the inclusion of the shrink net, have a particularly high resistance to tearing without the net being visible. If, for example, as outer material a surface structure containing fibres, such as felt, is chosen, then a tear resistant textile substitute is formed, which looks exactly like felt, since the net is invisibly contained therein. On the other hand the net especially if coloured, may be utilised to produce visual effects. By the application or inclusion of a net in accordance with the invention such fibre felts become

washable, since their structure is held together by the net. The appearance effects possible in such material may be enhanced by using a metal foil as coating layer. This makes it possible to obtain particularly striking effects.

A further use of the net is made by applying an adhesive coating to the openings formed by shrinkage. If this is a pressure sensitive adhesive cement firmly seated in the openings, then an adhesive sheet or adhesive strip, adhesive on both sides is obtained.

The net openings may be filled with any other substances which are retainable by the net. These include insulating materials, filler substances, cleaning agents, polishing and grinding agent, plant seeds, high frequency sensitive hot-melt adhesives and the like. When the process in accordance with the invention is based on a material web which shrinks subject to the influence of solvents, then solvents are best used for this which permit the material sheet concerned to swell. This swelling is generally accompanied by shrinking, whereby the net-form assumed by the sheet after shrinkage is maintained after evaporation of the solvent.

If a slit pattern is used in which the distance between the slits in one row, and the distance from one row to the next, amounts to about half the length of a slit, then a particularly useful net structure is obtained, i.e. a honeycomb latticework having net sides of substantially equal length. This net will stand up to particularly high stresses relative to its thickness. Furthermore, with this structure a high inherent stability is obtained.

Embodiments of the invention are shown in the accompanying drawings, in which:—

Fig. 1 shows a slitting pattern with individual straight slits, in which the openings caused by shrinkage are indicated as dotted;

Fig. 2 is a section through the slit, unshrunk sheet of Fig. 1;

Fig. 3 is a section through the shrunken sheet of Fig. 1;

Fig. 4 is a similar arrangement with straight slits in which the spacing between the rows is greater than the spacing between the slits in a row.

Figs. 5 to 15 show different patterns of slits;

Fig. 16 is a shrunken sheet with rows of mutually offset slits interspersed with rows which are not offset;

Fig. 17 is a net formed by shrinking which has a foil adhering to both sides;

Fig. 18 is a fibre felt sheet enclosed on both sides by a net;

Fig. 19 is a net, the openings of which are filled with an adhesive;

Fig. 20 shows diagrammatically a machine operating to produce a net of the invention;

Fig. 21 shows in section an arrangement for inserting adhesive droplets into a net;

Fig. 22 shows the same arrangement but forming an alternative shape of droplet;

Fig. 33 is a view of one side of a net with droplets.

Fig. 1 shows a slit pattern in a sheet in which individual, straight slits are arranged in rows such that the slits overlap one another from row to row. In this method of slitting the distance between the slits in one row and the distance from row to row is substantially half the length of a slit. When such a slit sheet is subjected to a shrinking process, then the openings shown in dotted lines are formed which are separated by webs R & T to form a honeycomb-shaped nut N.

Fig. 2 shows what the sheet F of Fig. 1 looks like in section. After shrinkage, a net structure N is produced as shown in Fig. 3 in section, with apertures O.

This net N has increased thickness relative to the sheet shown in Fig. 2. Thick webs T and R are formed which impart to the net N a high resistance to progressive tearing.

The slit structure shown in Fig. 1 may be widely varied. Fig. 4 shows such an alternative, in which the distance between rows of slits is large relative to the distance between the slits in a row. When such a slit sheet is subjected to a shrinking process, elongated openings are formed.

Further alternatives consist in making the ends of the slits of one row level with the beginnings of the slits of adjacent rows. Furthermore, it is possible to vary the length of slit from row to row, causing correspondingly different patterns to be formed.

Apart from straight slits, pattern-like forms of slits may be produced which impart a particular appearance to the shrunken material. This may be important for net curtains. Individual examples of such pattern-like forms of slits are shown in Figs. 5 to 15. A large number of other slit patterns are available.

A shrunken network in which there are rows which are not off-set between rows with slots mutually offset, is shown in Fg. 16. As shown, inclined webs have been formed between the rows with mutual offset. The region of the rows not having offset slots remains unopened. Thus a net with a particular stripe effect has been formed.

Fig. 17 shows a net 1 which is provided on both sides with further material sheets 2 and 3. The net imparts a high resistance to progresseve tearing to the composite structure. The sheets 2 and 3 may be applied by adhesion to the net 1. This adhesive application may be effected in that the net is heated to a softening temperature and sheets 2 and 3 pressed against the heated net.

In Fig. 8 a compound member is shown in which a fibre material, in this case a felt layer 4, supports nets 5 and 6 one on each side. Herein also the connection between the

felt layer 4 and the nets 5 and 6 may be produced by adhesion. When the felt layer has a suitable heat resistance, this adhesive application may be carried out by heating the nets 5 and 6 and pressing them against the layer 4. When a very loose fleece is concerned, it is preferable that the adhesive effect of both nets 5 and 6 extends through the fleece, so that at separate points the nets 5 and 6 are bonded together.

Fig. 19 shows a net 7, the openings 8 of which are filled with adhesive. This produces a self-adhesive sheet which is adhesive on both sides.

Fig. 20 shows a machine for carrying out a process in accordance with the invention. In this machine a slit shrinkable sheet 11 is forwarded in the direction of the arrow by means of the two feed rollers 9 and 10; it is then supported by the two rollers 12 and 13 so that between these two rollers a section 14 of freely suspended shrinking net is formed. Over this section 14 an infra-red radiator 15 with a reflector 16 is mounted so as to heat the section 14 to such an extent that shrinking occurs. The shrinkable sheet 11 is progressively conveyed by the roller 13 and then arrives between the two discharge rollers 17 and 18.

If, in connection with the machine described above a long chain polyethylene film is used with a length of slit of 4 mm, an interslit distance of 2.6 mm and a distance between rows of slits of 1 mm, and the rows of slits extend in the direction of feed of the sheet, the basic film having a shrinking ability of about 50%, then the supporting roller 12 is heated to 80°C and the supporting roller 13 to 60°C. The infra-red radiator 15 mounted about 5 cm over the web then imparts to the web during shrinking a temperature of about 115°C, with a feeding speed of 25m/min. Hexagonal honeycomb-like openings are then formed in the sheet.

In relation to the process according to the invention for producing a net structure from a shrinkable sheet it is possible to produce a three-dimensional structure by means of a known hot forming process. According to this process the net whilst hot from the heat shrinking process is placed between two co-acting heated shaping tools, formed to a required shape, and cooled. An example of such is, for instance, deep drawing.

In general, the process according to the invention for producing net structures in which the shrinking is induced by a heating process is advantageous in that it may be combined with other processes necessitating heating of the net structure.

Nets in accordance with the invention may be used as carpet backing and may replace hitherto used jute fabrics, more particularly because due to their manufacturing process they are dimensionally stable, and because utilizing their thermoplasticity they can be bonded without adhesive to the backs of the carpets under pressure, especially when the nets are made of PVC or a meltable compound.

Nets of anti-slip substances may be used with advantage underneath loosely laid floor coverings, such as nets being made from cheap sheet of soft PVC or polyethylene, of foamed material; anti-slip substances such as polyisobutylene or rubber-like thermoplastic co-polymers may be admixed or added as outer layers.

It is now possible to pack perishable goods from which air must not be excluded, such as flour, in plastic bags. Hitherto polyethylene films which have good properties from the nutritive-physiological point of view, could not be used for this purpose since either their permeability to air was too low or their physical strength insufficient. With the invention very thin sheets of upwards of 15 microns thickness may be combined with a net so as to give adquate air-permeability whilst the net provides the strength necessary for durability. Since the smooth sheet is inside, an anti-slip effect useful during storage is obtained.

In another embodiment, fibres are connected to a shrinkable film before or after slitting, by a known needling process. Subsequently the combined product is subjected to a shrinking treatment. Such shrinking results in the slits gaping into thicker ribs; also at the needle puncture holes where the fibres penetrate the film, the latter does not shrink apart to loosen the fibres, but closes up tightly around the fibres and locks them into position. This allows textile products resembling fleeces to be cheaply made. These fleeces may be used in various ways as packaging material, cheap discardable non-wovens, lining material, filler material, carpet filler, carpet underlay or carpet backing. Foamed sheet may also be used as shrinkable material, or activatable sheet containing a foaming agent as described later.

These materials may be impregnated coated or agglutinated. The use of a net in accordance with the invention as heat-activatable, perforated means for joining two layers may be greatly varied; thus the net may comprise a single layer or two or more layers, which are caused by heat to adhere to the materials to be connected. Adhesion-increasing additives may be added to the standard plastics material films, for example long-chain polyethylene, co-polymer (e.g. vinyl acetate-ethylene co-polymers) or polyisobutylene films, or the nets themselves may be made from an adhesive in film form. Such plastics materials have very strong adhesive properties at the time of agglutination, which are activated by heat, solvents, pressure or other measures, but the cohesive properties

may be regulated in such a way as to provide an adequately firm product at room temperature. Relatively soft or thin adhesive films may be supported during shrinking at a high temperature by webs or rollers with surfaces having non-adhesive properties.

The production of a shrinkable sheet from a thermoplastics foam in sheet from has already been referred to. The foaming of the thermoplastic material may alternatively be effected during the production of the net. Whereas foaming may usually be achieved from a shet with incorporated foaming agent before or after slitting, but before shrinking, there is a particularly expedient process if foaming of the plastics material takes place after the shrinking process from the intermediate net work product.

Example: to a granulated high molecular weight polyethylene material sold under the name Lupolen (R.T.M.) 1810 E. of Badische Anilin und Soda Fabrik A.G., having a melting index of 0.8 was added 1% of a blowing agent emitting nitrogen, sold under the name POROFOR (R.T.M.) type TR having a decomposition temperature of 175° C. The product was extruded on a blow type extruder at a temperature of 170°C with a blowing ratio of about 1:5 to a tubular sheet of about 175 microns thickness. During emission from the ring nozzle a certain foaming effect occurred which, however, was substantially reduced by the inflating and draw-off process, so that a relatively rough sheet with traces of bubbles was produced. This was subsequently provided with slits of 4.0 mm length, 2.6 mm interslit distance and 2.0 mm slit spacing, and heated on one side by infra-red radiators at a distance of 5 cm, so that the films became plastic and a net structure as shown in Fig. 11 was formed. Subsequently thereto the temperature was increased by means of further infra-red radiators at a distance of 4 cm to such an extent that the net was inflated from a net thickness of about 500 microns to about 850 microns. The product exhibited considerable strength at the periphery of the openings due to the surface skin formation.

Such products may be readily coated on one or both sides with adhesive, more particularly with pressure-sensitive adhesives which by suitable choice are not injurious to the foaming process. Of course, in such a case any points of contact such as guide rollers have to be non-adhesive. Such adhesives even if pressure sensitive adhesives are expediently applied from a melt, although application from a solution or dispersion with subsequent evaporaton of the solvent may be effected.

The adhesive itself may be applied as a foamable substance, so that it gains in volume and is better suited for agglutination with rough substrata, such as concrete floors, and such combined products may be used on carpet underlay so as to peelably fix a carpet to a floor when a pressure sensitive adhesive is used. A permanent adhesion is obtained when the adhesive is heat-activatable and sets by cooling between two substrates. In this manner net-like inserts may be consolidated between two layers, or the net may be used as carrier for one or more kinds of adhesives, which is particularly useful in the footwear industry, in order to connect footwear linings with uppers so as to be permeable to air, and resilient. Since the footwear industry is particularly interested in solvent-free, fast adhesives, both the net itself may be made of heat-activatable material and/or it may have suitable adhesives on one or both sides.

When adhesive coatings are to be applied, which at room temperature are relatively soft and delicate, then they are preferably applied to the already slit shrinkable web, more particularly since during the shrinking process owing to their generally short chain length or low viscosity at the increased shrinking temperature they offer substantially no resistance to the opening of the slits and web shrinking.

It has been shown, especially when a relatively low viscosity occurs at this increased temperature, that the adhesive can not only be carried by the shrinking ribs, so that it increases in thickness relative to the diminishing surface, but it even partly contracts at the intersection as a result of a further temperature increase, to form structures which for some purposes, especially spot agglutination, are particularly desired. Some compositions exhibit a natural surface activity which leads to a contraction and rounding into spherical shape to form drops which in a subsequent high speed cooling process can be "frozen".

It is observed in passing that when slitting delicate soft materials at room temperature causes difficulties, slitting may be facilitated by cooling the substrate or the cutting tools.

Finally, it should be mentioned that the net structure itself may be formed from a slit shrinkable web between two layers or below a single layer without these layers having to undergo the surface reduction. This is possible especially when there is no firm connection between the layers, when the bond is loosened by increasing temperature; thus for the purpose of agglutination of two textile webs, such as fabrics or fleece materials, an interposed slit sheet made of a ionomeric (See "Plastics Dictionary" 1967 edition, by Dr. K. Sloeckhert, Munich) synthetic resin based on polyethylene can not only be shrunk between these webs to produce a surface reduced net structure but also can subsequently be submitted to pressure to bring about an air-permeable bond between the two textile webs. The advantage of this is that in one process and with one heat source, the net can be produced and the webs bonded together. This

ionomeric resin is particularly suitable as raw material for textile agglutination inasmuch as it has an excellent adhesion at an increased temperature, whilst at room temperature it is reticulated. It also has very powerful bonding forces and owing to its high resistance to solvents, provides products quite resistant to chemical cleaning. The adhesive may be provided in the net as the centre of three plies; it is applied before slitting and shrinking between two shrinkable sheets and contracts therewith to a net structure which at room temperature is substantially free of stickiness. The net may be easily transported and is, for the purpose of agglutination, activated as described; pressure is necessary to press the adhesive in the direction of the web plane to a greater or lesser extent into the spaces between ribs. There is thus formed a series of internal rings bordering the net cavities, which is adhesive on both sides but leaves the centres free of adhesive for air permeability.

The adhesive may also be applied between the ribs instead of on the ribs; activation may be effected by solvents which are incorporated as micro-capsules in the adhesive and released by pressure. When adhesives or other compounds are inserted between the ribs, then the structure of such compounds may be changed by other suitable means.

Figs. 21 and 22 show a plastics compound 20 applied by means of rotating rollers 21, 22 of which one (21) carries this compound 20 along in a molten state, whilst the other (22) is cooled. The plastics material is forced into the spaces of the net structure 7, so that a droplet structure is formed. These droplets 23, depending upon the viscosity of the compound 20 on the application roller 21 form either into small spheres 24 to fill a corner of the net structure and which emerge from the net surface on both sides, or they draw out fibres of adhesive from the application roller 21 coating, which with increasing distance break off as the roller rotates to form bristles 25. In this manner bristles of 20 mm length have been obtained which may be used for adhesive or insulating purposes.

Besides acting as carrier for the plastics compounds the net may also act as a shaper therefor. Such compounds include those which set after cooling, or evaporation of solvents. Bitumen and tar-like compounds are possible either alone or with fillers, spinning compounds, paper compounds, filled plastics materials, and cross-linked or self setting compounds. Cement and clay-containing compounds can be used in plaster rendering carriers. The application of these compounds may be carried out by rollers, mortar coating, doctoring, film application from a sump, or any other manner. To improve or change the droplet structure air injection may be used; a self-adhesive plastics droplet structure may be used to secure a further layer, either of a sheet or of textile or mineral fibres.

Finally it should be noted that provided suitable material is chosen, the invention is equally applicable to film (less than 0.01" thickness) and about (greater than 0.01" thickness).

WHAT WE CLAIM IS:—

1. A process for the manufacture of a reticulated sheet from sheet webs which are shrinkable in at least one direction and made from a thermoplastic high polymer organic synthetic material, comprising the steps of forming substantially parallel rows of slits in the sheet, said slits of adjacent parallel rows being offset and said slits being disposed at right angles to said direction of shrinking of the sheet, and then subjecting the sheet to heat or solvent to effect a shrinking of the material web between the slits to a thickened form and to thus form net-like openings by opening of the slits.

2. A process as claimed in claim 1, in which said sheet web comprises a stretched thermoplastic sheet web which has been stretched for the purpose of obtaining an inherent ability to shrink at elevated temperatures at right angles to the later-made parallel rows of staggered slits.

3. A process as claimed in claim 1 or claim 2 in which the sheet web is so slit, that the ends of the slits of a row are aligned with the ends of the slits in the neighbouring rows.

4. A process as claimed in claim 1 or claim 2 in which the sheet web is so slit that the ends of the slits of a row lie between the slits of the neighbouring rows on either side.

5. A process as claimed in claim 1, in which the sheet web is also provided between the rows of staggered slits with rows of slits that are not staggered.

6. A process as claimed in any preceding claim in which the distance between the slits in a row and the distance between the rows is approximately half the length of the slits.

7. A process as claimed in any preceding claim in which there is an area of unslit material between a number of slits.

8. A process as claimed in any preceding claim in which a tube-like plastic sheet web is used, which is slit whilst in a flattened condition and is subsequently shrunk when expanded to tubular form.

9. A process as claimed in any preceding claim, in which several layers of sheet web are slit and shrunk together in such a way that the single layers combine to form a composite structure.

10. A process as claimed in any one of claims 1 to 9 in which at least two stretched plastic sheet webs provided with slits are placed one over the other, and are shrunk

by the application of heat so that they combine to form a composite structure.

11. A process as claimed in claim 9 or claim 10, in which differently coloured dyed plastic sheets are used.

12. A process as claimed in any preceding claim in which the sheet web is additionally provided on one or both sides with a coating and is subsequently shrunk.

13. A process as claimed in any one of claims 1 to 11, in which the sheet web is provided with slits, then provided additionally on one side or both with a coating and subsequently shrunk.

14. A process as claimed in claim 13, in which the sheet web and said coating or coatings have a different shrinking capacity with reference to said direction of shrinking at right angles to the slits.

15. A process as claimed in claim 1, in which the sheet web after being provided with said slits is shrunk and softened by application of heat and whilst hot a foil or sheet is applied to one or both sides, so that the sheet web adheres thereto on cooling.

16. A process as claimed in claim 15, in which the coating consists of a metal foil.

17. A process as claimed in claim 15, in which the coating consists of a laminar formation containing fibres.

18. A process as claimed in claim 13, in which the coating consists of an adhesive.

19. A process as claimed in any preceding claim in which to the sheet web is added a foaming agent working at the shrinking temperature.

20. A process as claimed in claim 1, in which the sheet web is provided with said slits and then with a coating on one or both sides applied hot, so that the heat transmitted from the coating or coatings to the web causes the shrinking of the slitted web.

21. A process as claimed in any preceding claim in which loose fibres are needled into the sheet web.

22. A process as claimed in any preceding claim, in which the sheet web provided with said slits is shrunk by the effect of heat and is converted into a three-dimensional shape by pulling the sheet into a shape at right angles to the plane of the web and allowing the sheet web to cool in this shape.

23. A process as claimed in any preceding claim substantially as hereinbefore described.

24. A reticulated sheet produced by a process as claimed in any preceding claim.

POTTS, KERR & CO.

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1293456 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig.1

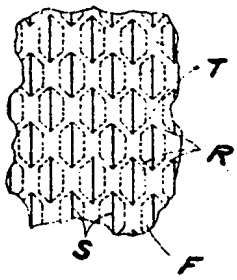


Fig.2

Fig.3

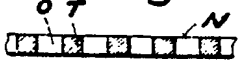


Fig.4

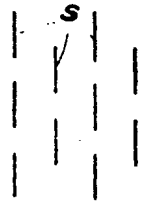


Fig.5

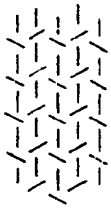
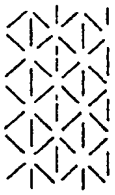


Fig.6

Fig.7



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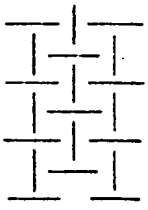


Fig.9

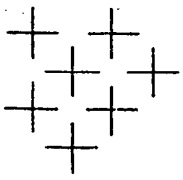


Fig.10

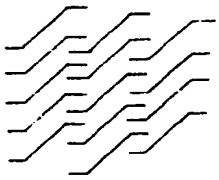


Fig.11

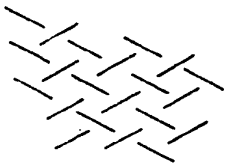


Fig.12

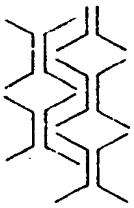


Fig. 13

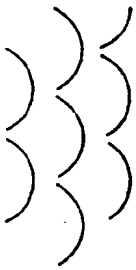


Fig.14

Fig.15

Fig. 16

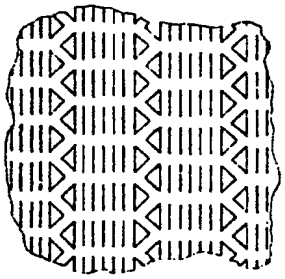


Fig.17

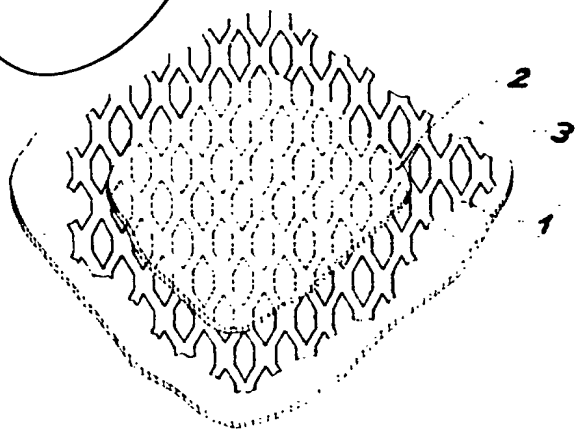


Fig.18

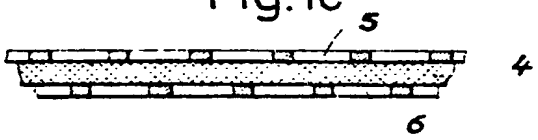


Fig.19

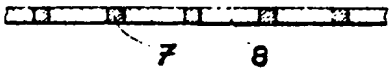
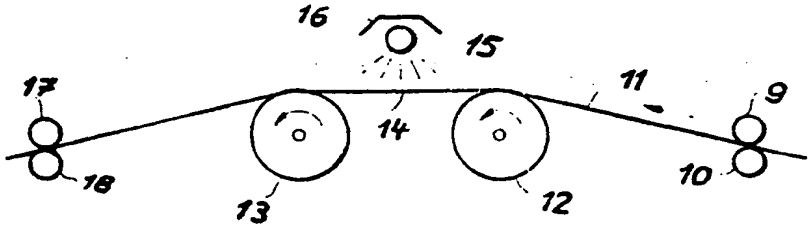


Fig. 20



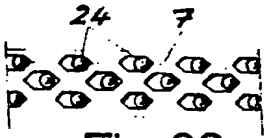


Fig. 23

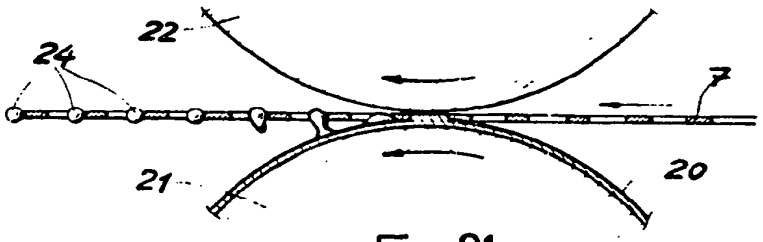


Fig. 21

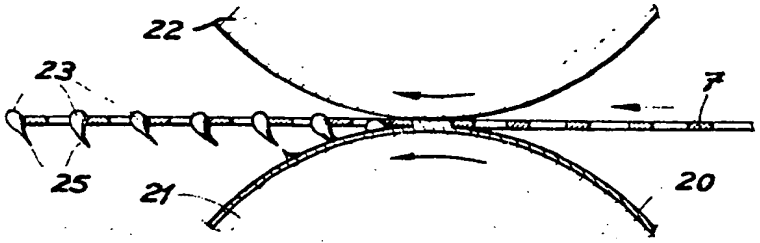


Fig. 22